THE MORPHOLOGY, STRUCTURE, AND DEVELOPMENT OF HYDRACTINIA POLYCLINA

By J. A. Place

With Plates VIII and IX

Contents

Introduction

During the summer of 1914, the Invertebrate Zoölogy class at The Marine Biological Laboratory, Woods Hole, while working on *Hydractinia polyclina,* experienced some difficulty in finding, and identifying Tentacular polyps. The question arose as to their constancy in the colony, and it was suggested by the instructors as a good subject for special work. The purpose of this paper is to offer a brief account of the morphology, structure, and development of the various kinds of polyps that exist in a colony of *Hydractinia polyclina.*

This work was carried on in the Department of Biology at Ohio University. I wish to thank Dr. W. F. Mercer, head of the department, for many valuable suggestions and for his generosity in giving us free access to the laboratory equipment. I also wish to thank Mr. J. T. Pickering, assistant in the department, for his assistance in preparing the accompanying figures.

Habitat

Hydractinia polyclina lives in a state of symbiosis with the Hermit-crab, forming over the shell of the latter a soft, pinkish covering. It appears that both are benefitted by this community life, for while the Hydractinia colony is furnished with transportation it, in turn, affords protection to the Hermit-crab, not only by obscuring its shell from view, but also by its possession of stinging cells by means of which it forms a defense against the enemies of the Hermit-crab.

The constant association of these forms together led to the belief that the life of the Hermit-crab was necessary to the existence of Hydractinia. That Louis Agassiz found them growing in abundance, attached to rocks in tide pools; that Samuel F. Clarke later found them growing on a wharf at Fort Wool, Chesapeake Bay; that two students of Woods Hole Laboratory found them growing on *Mytilus edulis* and Limulus; that during the summer of 1891, Dr. Conklin found them growing on the Fish Commission Wharf, Woods Hole; that they are frequently found growing on sponges about Woods Hole region; have proved their existence independently of the Hermit-crab. Besides having removed the occupants from shells bearing Hydractinia colonies, we placed the shells in wire baskets, and suspended them below low tide from a wharf. There we left them three weeks during which time the colonies became very luxuriant on the empty shells.

An additional advantage received by the Hydractinia colonies is that of food supply furnished by the young paguri. Miss Bunting reports that many of these are devoured by the polyps as they swim out from the maternal shell.

Material and Methods

The material for this work was obtained while studying at the Marine Biological Laboratory, Woods Hole, during the summer of 1914. The shells possessing Hydractinia colonies were found at low tide in Eel Pond. In order to prevent the polyps from contracting into abnormal shapes they were narcotized by adding, drop by drop, a solution of ten per cent chloreton in absolute al-

cohol till all power of contraction was lost. They were preserved in a four per cent formalin solution. For histological structure the best results were obtained with iron-hematoxylin stain. Sections were made from seven to twelve micra in thickness. Camera lucida drawings were made of various magnifications.

The Polyps

The gasterozoöids, as a rule, are the most numerous representatives of the colony; but, sometimes, during the summer months reproduction is so active that the blastostyles, occasionally, are equally as numerous. These are the longest of the polyps often exceeding one-fourth inch in length. They possess a conical hypostome terminating in a large mouth. Around the base of the hypostome are two circles of tentacles which increase in number with age from ten to thirty. The longest tentacles that occur on members of the colony are found here; they are crowded with nematocysts. The external surface is covered with a layer of ectoderm which is continuous with the upper ectoderm of the cœnosarc.

Since it is the function of this polyp to collect food for the entire commonwealth, it possesses the largest gastral cavity (Pl. VIII, Fig. 3). It is lined with a single layer of endoderm continuous with that of the endodermal canals of the cœnosarc.

The ectoderm and endoderm are separated by a thin structureless layer of mesoglœa which will not be referred to in description of the other polyps as it is common to all.

The blastostyles are either male, or female, though both sexes are never found in the same colony. The mouth, and gastral cavity are both small. A short distance below the mouth are two circles of tentacles varying in number from ten to thirty, but, unlike those of the gasterozoöids, are very rudimentary consisting of knob-like structures crowded with nematocysts. Immediately below the head the walls constrict into a narrow neck and, then, enlarge into a globular dilatation from which arise the sporosacs. In both sexes the reproductive cells arise in the body and migrate to the sporosacs. In female colonies the sporosacs are filled with eggs that can be seen through the thin ectodermal walls in the unstained, as well as stained, condition (Pl. VIII, Fig. 2). In the male

colonies the reproductive elements are small, very numerous, and stain more deeply than the body cells (Pl. VIII, Fig. 4). Below the sporosacs the body again narrows often into a slender thread.

The difference in appearance between the male and female colonies—the male sporosacs being often much elongated and of a yellowish tint while the female are rounded and rose-colored—caused Van Beneden to regard them as two distinct species which he described in a paper published in 1844 as *Hydractinia lactea* and *Hydractinia rosea.*

The dactylozoöids are about the same size throughout their length. Their distal extremity is surrounded by a circle of rudimentary tentacles from ten to sixteen in number. There is a very small mouth in the center. These have strong, muscular walls and are capable of coiling and uncoiling themselves. As their function is chiefly to protect the other members of the colony they possess an abundance of nematocysts (Pl. VIII, Fig. 1).

The tentaculozoöids are extremely slender though often exceeding the dactylozoöids in length (Pl. VIII, Fig. 5). They are capable of great extension and are characterized by Mr. Hincks as floating like long fishing lines through the water. In preserved material, on the other hand, they are contracted to such an extent as to render them extremely difficult to find. They are situated near the outskirts of the colony, and are usually few in number as compared with other members. The tip, only, is covered with nematocysts. No mouth is present, and the gastral cavity is very small.

These were regarded by Allman as abnormal dactylozoöids on account of their paucity. Colcutt, however, found them present in every colony of *Hydractinia echinata* and considered them as normally present; Mr. Hincks reports them as constantly occurring. He also states that he distinguishes no difference between his *Hydractinia echinata,* and *Hydractinia polyclina* of Agassiz. I have found the *Hydractinia polyclina* of Woods Hole region to correspond in every particular with Colcutt's Hydractinia echinata, but the skeleton differs in minor details from that of *Hydractinia echinata* as described by Mr. Hincks to which reference is made under the discussion of the skeleton.

The Skeleton

The skeleton is a chitinous structure which forms an irregular crust on univalve shells, or other objects on which the colony is growing. The skeletal structures penetrate the shell by dissolving the calcareous substances with an acid, or erosive agent which the animal secretes. The chitin is then secreted by the lower ectoderm of the cœnosarc in thin layers (Pl. IX, Fig. 4). These are so closely attached to the shell that the latter must be dissolved away with dilute hydrochloric acid in order to obtain good specimens of skeleton. Pieces of skeleton can then be cut from the shell and thin sections made.

The skeleton is overlaid by cœnosarc consisting of two layers of ectoderm enclosing between them a number of endodermal tubes which branch, and anastomose promiscuously. These are connected at intervals with the canals of the polyps whose ectoderm, and endoderm are continuous respectively with the upper ectoderm of the cœnosarc, and the endoderm of the tubes. In this way the gastral cavities of all members of the colony are placed in direct communication with each other.

At intervals, the skeleton projects above the cœnosarc forming conical smooth spines, and spinules. These sometimes form bridges of chitin over an intercommunicating tube which led Mr. Hincks to conclude that the chitinous covering existed above, as well as below the cœnosarc (Pl. IX, Fig. 4).

Carter (1873) tells of a specimen in the British Museum in which the whole of the shell has become transformed into the hornlike skeleton of Hydractinia. From the smooth internal appearance, he infers that the shell had been tenanted by an Eupagurus which left after the entire shell had been transformed.

Histology

The lower ectoderm of the cœnosarc is composed of long slender cells quite irregular in shape. They are more or less vacuolated, and contain a single nucleus situated near the center of the cell. The nucleus is oval in shape, and contains several nucleoli. It is

the function of this layer to secrete, extend, and renew the chitinous skeleton.

The upper ectoderm of the cœnosarc is formed of a single layer of cells more regular in size, and more cubical in shape. Nematocysts are occasionally present in this layer. (Pl. IX, Fig. 4).

This layer is continuous with that of the polyps, the main difference in the latter being a greater variation in shape of their cells.

The endoderm of the cœnosarc is made up of a single layer of cubical cells containing a single, oval nucleus in their center.

In the gasterozoöids the endoderm contains long, narrow cells which vary in length so that the free ends are not at the same level. In this way longitudinal ridges are formed in the lumen which in cross section present a very irregular appearance (Pl. IX, Fig. 3). As this is especially characteristic of the nutritive polyps, it is evident that even in this low form of life the rudimentary alimentary canal is thrown into elevations for the increase of surface.

These cells are wider at their free ends, and are vacuolated. Their nuclei are oval, are situated near the middle region of the cell, and possess one or more nucleoli.

The endoderm of the blastostyles is composed of long, narrow ciliated cells. In the head region these often contain several nuclei, but in the body they possess a single, large nucleus.

The endodermal cells of the dactylozoöids are approximately equal in size. They usually contain many vacuoles, and a single nucleus which is situated in the middle of the cell.

The tentaculozoöids possess long, narrow cells which are more regular in size and shape than those of the other polyps.

Embryology

The ova have their origin in any part of the endoderm below the gonophores, and migrate upward between the ectoderm and endoderm until they reach the gonophores. Here they remain till they ripen and are laid (Pl. VIII, Fig. 2).

The origin of the sperm cells is a little more complicated. At the outset the ectoderm of the gonophore begins to divide into two layers, the inner one of which stains deeply and is destined to form the sexual cells. This layer, in turn, divides into two, an outer

thin layer consisting of a single row of cells, and an inner one which rapidly separates into several rows of cells. These stain deeply and are known as spermatoblasts. They become specialized to form the mature spermatozoa.

The ova are fertilized at the moment of ejection. The polar bodies are rapidly given off, cleavage takes place, and a ciliated planula is formed. This becomes attached at one end, elongates, and tentacles are formed at the other. At the basal end prolongations are given off to form the beginnings of the tubular network. These subdivide promiscuously, the intervening spaces being gradually filled in by the extension of the cœnosarc, and the secretion of spines and spinules.

Conclusions

1. *Hydractinia polyclina,* though almost invariably associated with the Hermit-crab, is capable of an independent existence.

2. In every Hydractinia colony there are normally present four kinds of polyps:

Gasterozoöids.

Blastostyles.

Dactylozoöids.

Tentaculozoöids.

3. The function of the gasterozoöids is to collect, digest, and absorb food for the entire colony; that of the blastostyles is reproduction. The function of both the dactylozoöids and tentaculozoöids is to defend the colony against enemies, the latter being especially adapted to this service by reason of its great length.

4. Judging from the accounts of the many investigations made upon *Hydractinia echinata,* we have concluded that it is identical with *Hydractinia polyclina.*

Department of Biology,
Ohio University, Athens, Ohio.

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Explanation of Plates

Plate VIII

Fig. 1.	Dactylozoöid	x 96.
Fig. 2.	Female blastostyle	x 96.
Fig. 3.	Gasterozoöid	x 38.
Fig. 4.	Male blastostyle	x 55.
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Fig. 6. A colony of Hydractinia polyclina growing on an Eupagurus shell.

Plate IX

Fig. 1.	Cross section of male gonophore	x 413.
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Abbreviations

Ch, chitinous skeleton.
E, Egg.
En, Endoderm.
ec, Ectoderm.
G, Gonophore.
G.C, Gastral cavity.
h, Hypostome.
L.Ec, Lower ectoderm.
L.En, Lower endoderm.
M, Mouth.
mes, Mesoglœa.
n, Nucleus.
n.c, Nucleolus.
R.T, Rudimentary tentacles.
S.c, Sperm cells.
Sp, Spine.
T, Tentacle.
up.ec, Upper ectoderm.
up.en, Upper endoderm.

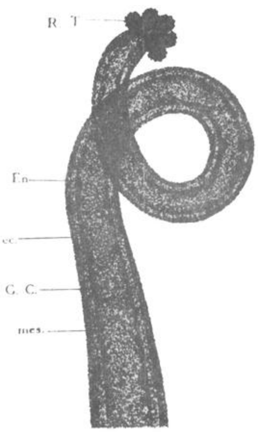

Fig. 1

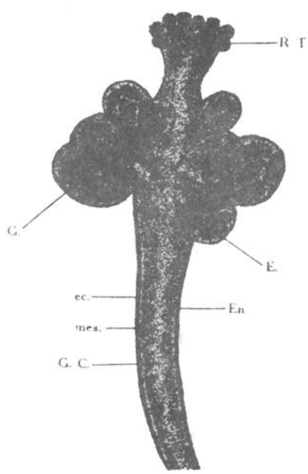

Fig. 2

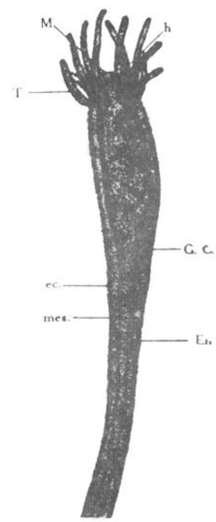

Fig. 3

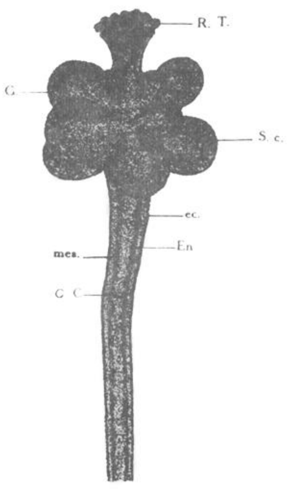

Fig. 4

Fig. 5

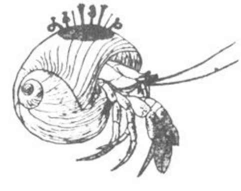

Fig. 6

PLATE VIII

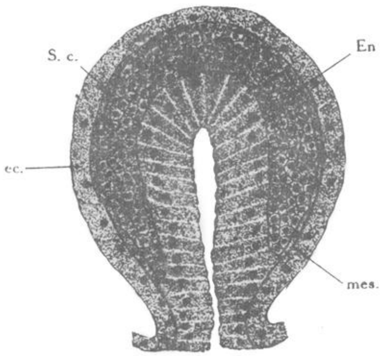

Fig. 1

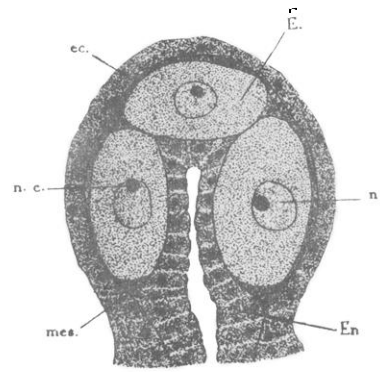

Fig. 2

Fig. 3

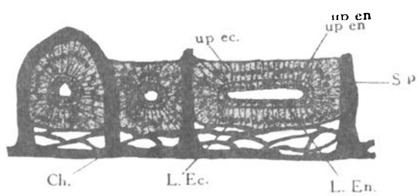

Fig. 4

PLATE IX